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The Trilobites *Bathyurus* and *Eomonorachus* from the Middle Ordovician of Oklahoma and Their Biofacies Significance

Rolf Ludvigsen

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The Trilobites *Bathyurus* and *Eomonorachus* from the Middle Ordovician of Oklahoma and Their Biofacies Significance

Abstract

Two trilobites, *Bathyurus superbus* Raymond and *Eomonorachus divaricatus* (Frederickson), occur in the upper Bromide Formation at Fittstown, Oklahoma. Assessment of the geographic occurrences of distinct trilobite associations, the companion faunas, and the enclosing lithology permit provisional recognition of two trilobite biofacies in southern Oklahoma: a shallow-water biofacies developed on the platform (''Bromide dense'') and a deeper-water biofacies developed within the downwarped Southern Oklahoma Aulacogen (Pooleville Member).

A lectotype for *Bathyurus superbus* is selected and the species is redescribed.

Introduction

Bathyurus Billings occupies an important position in the Middle Ordovician biostratigraphic framework of North America. It is one of the few trilobites found in near-shore carbonate mud environments, in, for example, the Black River Group of New York and Ontario, and must, of necessity, be relied upon for correlation. Although the genus has occasionally been used to define strata of Blackriveran or Wilderness age, it appears to be a better indicator of shallow-water conditions than of any specific age within the Middle Ordovician interval. Recent evidence indicates that *Bathyurus* first appears at a level well below those carrying late Chazyan faunas in northern Canada (Ludvigsen, 1975; Chatterton and Ludvigsen, 1976). Even though the occurrence of the genus carries only limited age significance, it can still successfully be used for age assignments, but the requisite correlation must be performed at the species level, as it must for virtually all other Ordovician trilobites.

During the Middle Ordovician the Bathyuridae underwent a diversity decline from about 12 genera in the Whiterockian to a single genus in the Shermanian. *Bathyurus*, the only genus of the family to survive the Chazyan, persisted to near the close of the Blackriveran. The diversity decline of the family Bathyuridae was not accompanied by a reduction in its geographic range. *Bathyurus* has a wide, and essentially circum-cratonic, distribution in the Chazyan and Blackriveran of North America, typically occurring in micrites and calcilutites of demonstrably shallow-water (intertidal and shallow subtidal) origin and in association with only sparse faunas. According to published information, *Bathyurus* has been found in Nevada and Utah (Ross, 1967a, 1970), Northwest Territories (Ludvigsen, 1975), Canadian Arctic Islands (Thorsteinsson, 1958; Norford, 1966), western Newfoundland (Billings, 1865), Mingan Islands (Twenhofel, 1938), western New York and southern Ontario (Wilson, 1947; Whittington, 1953), Pennsylvania (Whittington, 1953), southwestern Virginia (Butts, 1941), and Kentucky (Ross, 1967b).

The remaining 2500-km gap in the southern circum-cratonic distribution of *Bathyurus*, between Kentucky and Utah, may now be partially filled. A well-preserved cranidium and hypostome of *Bathyurus superbus* Raymond were collected by Valdar Jaanusson and Walter C. Sweet from the highest Bromide Formation ("Corbin Ranch Formation" or "Bromide dense") at the Highway 99 Section, 5 km south of Fittstown, Oklahoma (Fig. 1). Dr. Jaanusson kindly passed these specimens on to me for study. The only other trilobite collected at this locality is *Eomonorachus divaricatus* (Frederickson, 1964).

This occurrence contributes towards a biofacies synthesis of Ordovician trilobites, one that has far-reaching implications for Middle Ordovician biostratigraphy of North America. Southern Oklahoma is one of the few areas in North America where the age equivalence of a sparse shallow-water trilobite fauna (with *Bathyurus*) and rich deeper-water trilobite faunas (lacking *Bathyurus*) may be established with reasonable certainty.

Bathyurus superbus has previously been known only from a single locality in the Black River Group at Ottawa, Ontario.

Stratigraphy and Faunas

The Corbin Ranch Formation was established by Harris (1957) for about 6.5 m of "hard, dense to lithographic, off-white, fossiliferous limestone, with thin, calcareous, grey-white, fossiliferous shales" separated by disconformities from the underlying Bromide Formation and the overlying Viola Formation in southern Oklahoma. The faunas of the Corbin Ranch are sparse and of shallow-water aspect and consist of *Receptaculites*, large "algal? ringlets" (Harris, 1957; possibly oncolites), the rhynchonellid brachiopod *Ancistrorhyncha*, four genera of ostracods (mainly leperditiids and leperditellids), and two trilobites (*Bathyurus* and *Eomonorachus*).

The name Pooleville Member of the Bromide Formation was proposed by Cooper (1956) for the sequence of interbedded limestones and shales lying between the Mountain Lake Member of the Bromide and the Viola Formation. The Pooleville Member is 76 m thick at the type section on Spring Creek, some 70 km west-southwest of Fittstown, and is exposed at many localities in the western Arbuckle Mountains and the Criner Hills. The faunas are highly diverse and consist, in part, of 39 genera of brachiopods (Cooper, 1956), 16 genera of trilobites (Shaw, 1974), and 30 genera of ostracods (Harris, 1957).

Fay and Graffham (*in* Ham, 1969, figs. 16, 32) included the Corbin Ranch Formation in the Pooleville Member and presented a cross-section of the

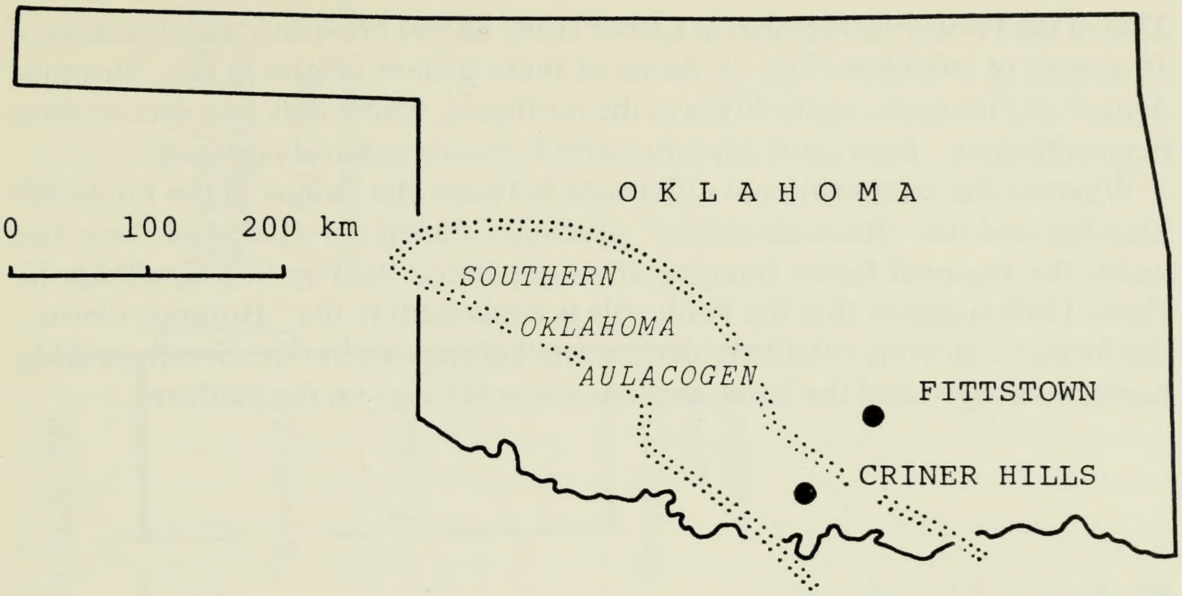


Fig. 1 Locality map of Oklahoma.

Bromide Formation in which 18 m of fine-grained and dense limestone at Fittstown (the "Bromide dense", including the type Corbin Ranch Formation) passes laterally into 39 m of limestone and shale at Criner Hills (the Pooleville Member) – the line of facies change being along the eastern margin of the Southern Oklahoma Aulacogen (Hoffman *et al.*, 1974), here approximately defined by the trace of the Reagan Fault. Such stratigraphic analysis implies that a relatively thin and shallow-water carbonate sequence on the stable platform was replaced to the southwest, towards the depositional axis of the Southern Oklahoma Aulacogen, by a thicker sequence of deeper-water limestones and shales and that the faunal difference between the "Bromide dense" and the remaining Pooleville Member is a result of environmental differences.

A massive bedded and lithographic top member of the Bromide Formation that overlies the Pooleville facies at a number of localities was assigned by Harris (1957) to the Corbin Ranch Formation and by Fay and Graffham (*in* Ham, 1969) to the "Bromide dense".

The faunas do not aid in ascertaining the exact position of the "Bromide dense" relative to the Pooleville Member in the areas where the former overlies the Mountain Lake Member. Harris (1957) considered the Corbin Ranch to be younger than the Bromide, but cited as evidence merely the abrupt change in ostracod faunas. Only a single ostracod species, *Eoleperditia fabulites*, occurs in both units and this species ranges through most of the Middle Ordovician in other parts of North America (Copeland, 1974, Text-fig. 4). The brachiopod *Ancistrorhyncha costata* occurs in the type Corbin Ranch and was reported from the highest beds of the Pooleville Member at a number of localities (Cooper, 1956). The occurrences in the Pooleville (the *Ancistrorhyncha* Zone of Cooper) are in the massive bedded and lithographic top member that Harris (1957, p. 95) assigned to the Corbin Ranch Formation. Thus, *A. costata* appears to be confined to the "Bromide dense". The highly diverse brachiopod faunas recorded from the Pooleville by Cooper (1956) do not reach the "Bromide dense". The change in trilobite faunas between the Pooleville and the "Bromide dense" is equally pronounced. From three localities in the upper

23 m of the Pooleville Member at Criner Hills, Shaw (1974) illustrated species of 16 genera of trilobites (Fig. 2). None of these genera occurs in the "Bromide dense" at Fittstown, some 70 km to the northeast, where only two species have been collected – *Bathyurus superbus* and *Eomonorachus divaricatus*.

Whereas the compositional difference between the faunas of the Pooleville Member and the "Bromide dense" precludes faunal correlation of these two units, the regional facies interpretation presented by Fay and Graffham (*in* Ham, 1969) suggests that the Pooleville is equivalent to the "Bromide dense", the former reflecting relatively deep-water settings within the Southern Oklahoma Aulacogen and the latter shallow-water settings on the platform.

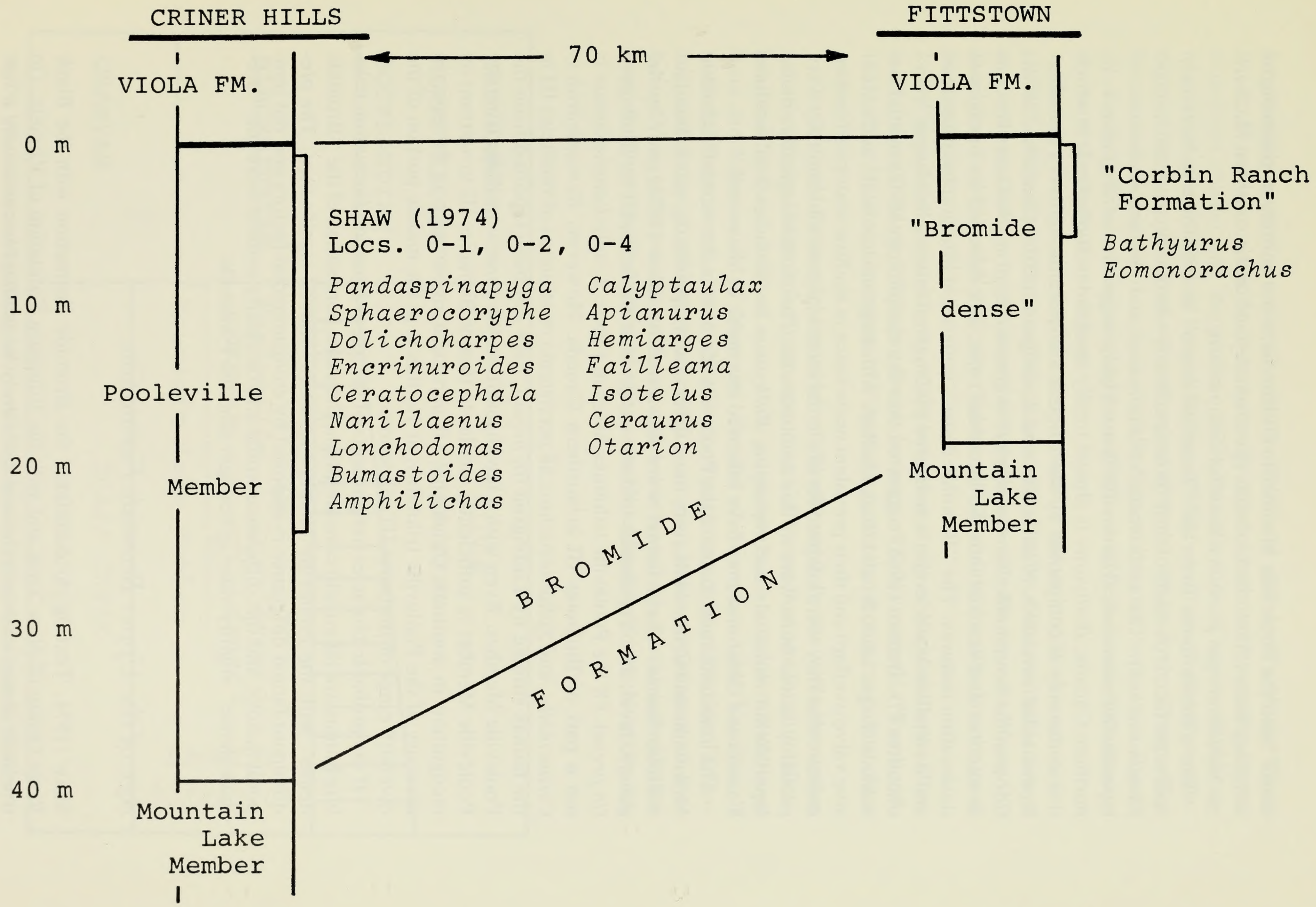
Biofacies Significance

Within the Lower Palaeozoic, biofacies and community studies have mainly concentrated on the sessile benthos (brachiopods, bivalves, corals). The vagile benthos (particularly trilobites and ostracods) have received only scant attention along these lines, but recently the biofacies concept has been applied with considerable success to Late Cambrian trilobite assemblages of western North America (Cook and Taylor, 1975; Taylor, 1977) and to Ordovician trilobite assemblages of Spitsbergen (Fortey, 1975) and northern Canada (Chatterton and Ludvigsen, 1976; Ludvigsen, *in press*). Other biofacies studies of Ordovician trilobites are few. Walker (1972) presented evidence that *Bathyurus* in the Black River Group of New York was restricted to shallow subtidal and intertidal zones. The deeper and more diverse level bottom community in the Black River Group lacks trilobites.

A recent study of large silicified trilobite faunas from the upper Sunblood, Esbataottine, and lower Whittaker Formations (Chazyan to Edenian) of the southern Mackenzie Mountains, District of Mackenzie (Ludvigsen, *in press*) outlined four coeval trilobite biofacies – three on a broad carbonate platform (from shallow to deeper settings – Biofacies I, II, III) and one on the adjacent fine clastic slope (Biofacies IV). The biofacies were defined on the presence of broadly outlined generic groups and on patterns of species diversity. Of these, Biofacies I and III are of particular relevance to the Oklahoma trilobite assemblages. Biofacies I consists of low-diversity associations of a single to six species of trilobites in a hypothetical sample of 100 individuals; the interior portions of this biofacies consist solely of *Bathyurus*. Biofacies III consists of high-diversity associations of nine to 19 species in a similar sample.

If the compositional information of the trilobite faunas from the "Bromide

Fig. 2 Cross-section of upper Bromide Formation from Fittstown to Criner Hills showing position and composition of trilobite assemblages referred to in the text. Modified from Ham (1969) and Shaw (1974). *Hemiarges* = *Amphilichas subpunctatus* Esker (in Shaw, 1974, pl. 11, figs. 2–4, 8, pl. 12, fig. 12) and *Failleana* = *Platillaenus* sp. (in Shaw, 1974, pl. 3, fig. 9). See Chatterton and Ludvigsen, 1976, for discussion of these assignments. *Isotelus* = *Homotelus bromidensis* Esker.


CRINER HILLS
FITTSTOWN
70 km
VIOLA FM.
VIOLA FM.
0 m
10 m
20 m
30 m
40 m
Pooleville
Member
Mountain
Lake
Member
SHAW (1974)
Locs. 0-1, 0-2, 0-4
Pandaspinapyga
Sphaerocoryphe
Dolichoharpes
Encrinuroides
Ceratocephala
Nanillaenus
Lonchodomas
Bumastoides
Amphilichas
Calyptaulax
Apianurus
Hemiarges
Failleana
Isotelus
Ceraurus
Otarion
BROMIDE
FORMATION
"Bromide
dense"
Mountain
Lake
Member
"Corbin Ranch
Formation"
Bathyurus
Eomonorachus

dense" and the Pooleville Member in Oklahoma is not entirely attributable to sampling biases, then the biofacies spectrum defined in the southern Mackenzie Mountains can provide a basis for comparison.

The trilobite fauna from the "Bromide dense" at Fittstown is extremely sparse (in fact, it consists of only three specimens – two *Bathyurus* and a single *Eomonorachus*). The occurrence of *Bathyurus* and the preponderance of leperditellid ostracods (Harris, 1957) are highly suggestive of Biofacies I. In northern Canada, *Bathyurus* is almost totally confined to Biofacies I, in which it is commonly accompanied by the trilobite *Calyptaulax* and very abundant leperditellid ostracods (Chatterton and Ludvigsen, 1976; Copeland, 1974). *Calyptaulax* is not unlike *Eomonorachus* in general features. Biofacies I occurs in micrites and extends into the intertidal zone, as evidenced by occasional desiccation features. The "Bromide dense" consists of lithographic limestone and its shallow-water origin is indicated by fenestral fabric ("birdseyes") and oncolites (?). Berdan (1968) suggested that the morphology of leperditiid ostracods (large, smooth, and thick-shelled, with large muscle scars and extensive valve overlap) and their prevalent occurrence in shallow-water carbonates indicate that they were adapted for life in the intertidal zone and that they were probably active burrowers in this environment. The morphologically similar leperditellid ostracods accompanying *Bathyurus* in Biofacies I of northern Canada and Oklahoma may have followed this mode of life as well.

The limestones and shales of the Pooleville Member in the western Arbuckle Mountains and Criner Hills carry more diverse and, apparently, more abundant trilobite faunas. These faunas were illustrated by Shaw (1974) and, on the generic level, are very similar to those assigned to Biofacies III by Ludvigsen (*in press*). Of the Pooleville trilobites listed in Figure 2, only *Lonchodomas* is not a part of Biofacies III in northern Canada. However, *Remopleurides*, *Ceraurinella*, and *Sphaerexochus*, all persistent constituents of Biofacies III in the faunas studied by Ludvigsen (*in press*), have not been reported from the Pooleville Member. Even with a few disparities, the generic package from the Pooleville Member is sufficiently similar to that of Biofacies III to warrant its recognition in southern Oklahoma. Of particular importance is the species diversity of the Pooleville trilobites; at 16, this is in the middle portion of the diversity range of Biofacies III collections.

If the probable biofacies assignments of the upper Bromide Formation trilobite faunas are taken into consideration, the exact correlation of the "Bromide dense" with the Pooleville Member assumes reduced significance. The predominant faunal difference is imposed by environmental factors and not temporal factors, and this difference would still be clearly evident were the "Bromide dense" slightly older or younger than the Pooleville.

Age of the Upper Bromide Formation

Shaw (1974, Text-fig. 6) correlated the Bromide Formation with the Black River Group of New York and with the Edinburg Formation of Virginia. On trilobites alone, such correlations can barely be justified because only a few long-ranging species are shared with the Edinburg and none with the Black River. That these correlations are basically correct is shown by studies on the conodonts (Sweet and Bergström, 1973), brachiopods (Cooper, 1956), ostracods (Harris, 1957), and corals (Bassler, 1950), which also indicate correlations of, at least, the Pooleville Member with the Black River Group. The occurrence of *Bathyurus superbus* in the highest Bromide supports a Blackriveran assignment of this unit and provides the only definite trilobite connection with the Black River Group.

The only stratigraphic horizon that previously has yielded *Bathyurus superbus* is the Pamelia Formation at Mechanicsville, Ottawa, Ontario (that is, lower Black River Group). In this area the Pamelia can only be separated from the overlying Lowville with difficulty (Barnes, 1967) and the locality data may not be conclusive.

The genus *Eomonorachus* typically occurs in strata of Kirkfieldian to Shermanian age (DeMott, 1963), but the occurrence of *E. holstonensis* (Raymond, 1925) in the Holston Limestone of Virginia suggests that it may range into older rocks.

The Bromide Formation is overlain disconformably by the Viola Formation which contains, in its lower part, conodonts of Fauna 9 at one locality (Kirkfieldian/Shermanian, Sweet *et al.*, 1971), a trilobite fauna correlative with those from the Kimmswick of Missouri, Prosser of Minnesota, and Verulam of southern Ontario and containing among other genera, *Cryptolithoides*, *Trinodus*, and *Robergia* (Whittington, 1952) – an association reminiscent of Biofacies IV, a sparse brachiopod fauna which was tentatively correlated with that from the Decorah Formation of Minnesota (Rocklandian/Kirkfieldian) by Al-

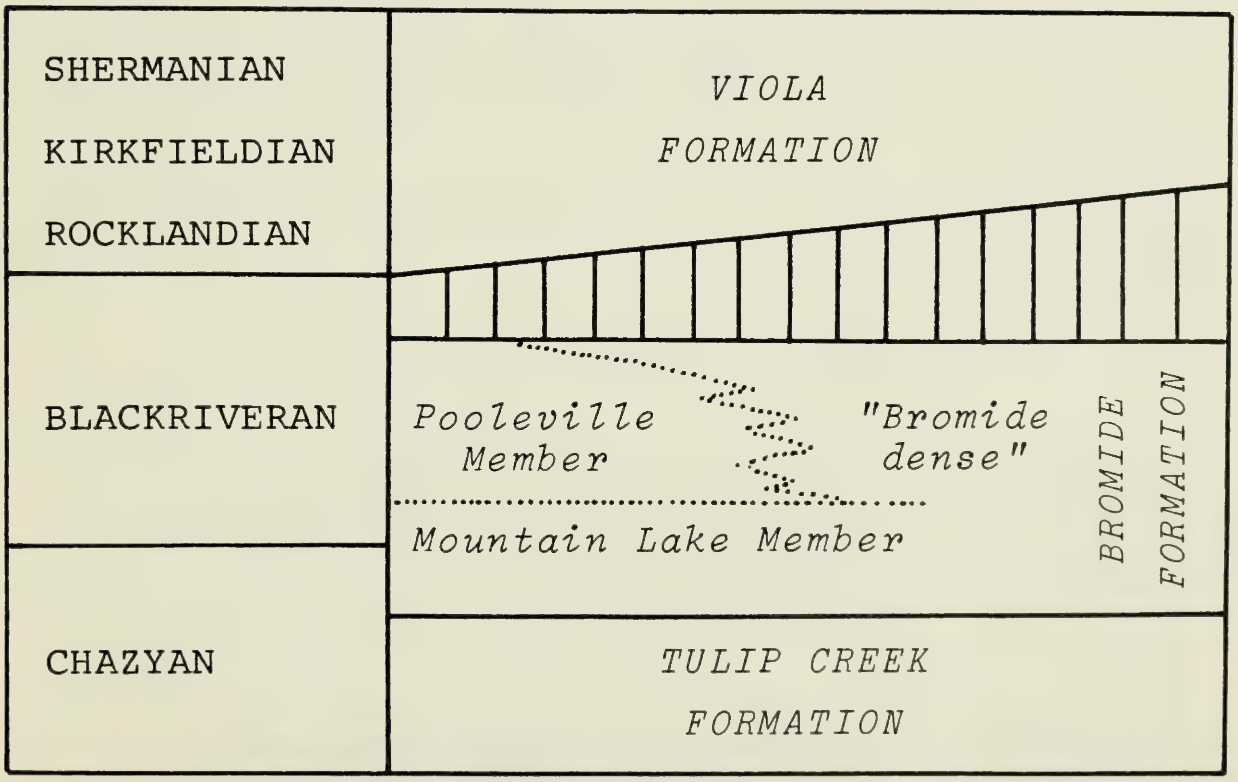


Fig. 3 Inferred relationship and ages of late Middle Ordovician formations in southern Oklahoma.

berstadt (1973), and graptolite faunas assignable to the *Orthograptus truncatus intermedius* Zone (Shermanian and older?; Berry, 1960).

The presence of a disconformable lower contact of the Viola seems well established (Ham, 1969). The faunal change between the Bromide and the Viola, however, is largely the result of superpositioning of biofacies and not necessarily indicative of a significant hiatus (Fig. 3). In terms of trilobite biofacies, the Bromide-Viola contact marks a change from Biofacies I and III below, to possibly Biofacies IV above. The late Middle Ordovician geological events in Oklahoma, therefore, include a regression during the late Blackriveran, resulting, initially, in the basinward migration of shallow biofacies and, finally, in the emergence and, possibly, partial erosion of the Bromide limestones. In the early Trentonian, an abrupt transgression brought deeper-water biofacies of the Viola over the unconformable lower contact and towards the craton.

Systematic Descriptions

Repositories

Royal Ontario Museum, Toronto (ROM), Geological Survey of Canada, Ottawa (GSC), Naturhistoriska Riksmuseet, Stockholm (Ar), National Museum of Natural History, Washington (USNM), and University of Oklahoma, Norman (OU).

Order Proetida Fortey and Owens, 1975
Family Bathyuridae Walcott, 1886

Genus *Bathyurus* Billings, 1859

Type species

Asaphus? *extans* Hall from the Lowville Formation, Mohawk Valley, New York State.

Bathyurus superbus Raymond, 1910

Fig. 4 A–I

1910 *Bathyurus superbus* Raymond, p. 129, pl. 2, figs. 1–3.
1947 *Bathyurus superbus* Raymond, Wilson, p. 18, pl. 2, figs. 9, 10.
1953 *Bathyurus superbus* Raymond, Whittington, p. 653, pl. 69, fig. 28.
1970 *Bathyurus superbus* Raymond, Norford *et al.*, pl. 4, fig. 1.

Lectotype (here selected)

An incomplete specimen (ROM 18788) illustrated by Raymond (1910, pl. 2, fig. 3) and Whittington (1953, pl. 69, fig. 28). Refigured here as Fig. 4E.

Occurrences

The type lot from Ontario was collected by J.E. Narraway and P.E. Raymond from the Pamelia Formation at La Petite Chaudière, Mechanicsville, Ottawa. The material from Oklahoma was collected by V. Jaanusson and W.C. Sweet from the uppermost Bromide Formation (''Bromide dense'') at the Highway 99 Section, 5 km south of Fittstown.

Description

Bathyurus superbus remains an easily-identifiable species. Figure 4 is arranged to facilitate comparison with its closest relative, *Bathyurus extans* (compare Fig. 4E and I with J and K). Below is presented a brief redescription of *B. superbus* based on the type material from Ontario and the new specimens from Oklahoma.

The glabella is essentially parallel-sided, one and a half times as long (sag. including occipital ring) as wide (tr.) and only slightly inflated. It expands slightly in front of the palpebral lobes. The lateral glabellar furrows are either extremely faint or absent (the depressions visible on the glabella illustrated in Fig. 4I may be faint lateral glabellar furrows). With the exception of fine wrinkles on the posterior half of the occipital ring and on the anterior part of the glabella, the cranidium is smooth. The palpebral lobe is small and lacks a palpebral furrow. The genal spine is comparatively short, reaching only as far posteriorly as the fourth thoracic segment. The cephalic border is broad and flat.

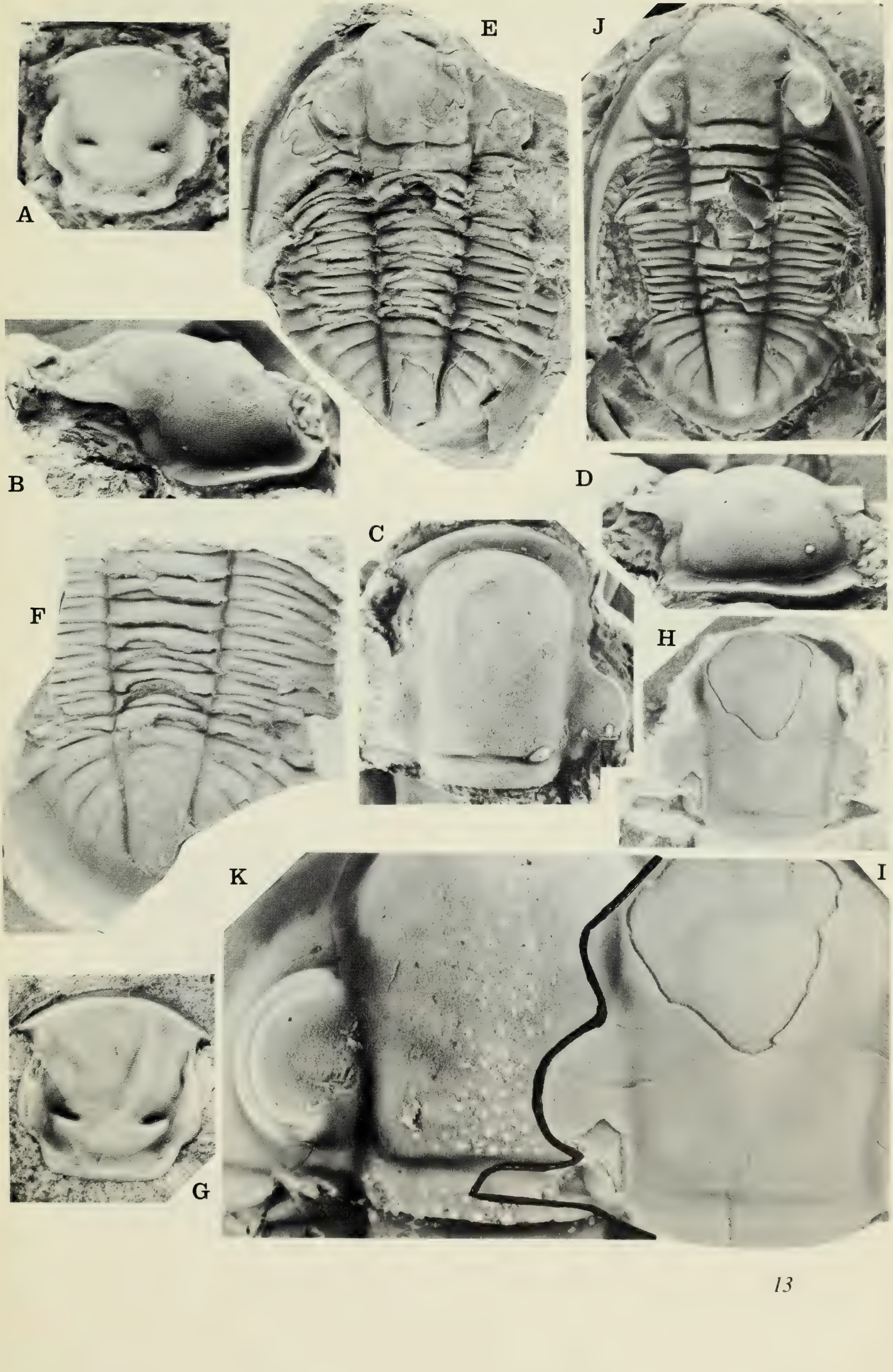
The hypostome of *Bathyurus superbus* was briefly described by Raymond (1910), but not illustrated. Whittington (1953) stated that this hypostome could not be located among the original material. A search of the type lot in the Royal Ontario Museum turned up a single large hypostome (Fig. 4G), which agrees with Raymond's description (if allowance is made for his reversal of front and back). This hypostome is very similar to that from the Bromide Formation of Oklahoma, but is about four times as large. The hypostome is about as long (sag.) as wide (tr.) and approximately square in outline. The middle body is only slightly inflated and bounded laterally and posteriorly by broad and shallow border furrows. The middle body reaches the curved anterior margin, which carries a short (sag.), concave, anteriorly-facing band for its complete width. This concave band fitted snugly against a corresponding convex band, which formed the posterior edge of the rostral plate (*see Bathyurus* aff. *extans* in Ludvigsen, 1975, pl. 4, fig. 23). The macula is located two-thirds the distance back on the middle body, just inside the lateral border furrow. It is moderately impressed with a steep posterior and a shallow anterior slope and its posterior edge is defined by a narrow lip. The posterior margin of the hypostome is very slightly bowed between the extended and rounded posterolateral corners. Towards the front, the lateral margin flares into a distinct rounded shoulder, which, in lateral profile, appears to be broad and tongue-like. Between the shoulder and the base of the anterior wing, the margin is deflected into a laterally-concave antennal notch. The microsculpture on the middle body consists of very fine, transversely disposed, cuesta-like ridges, whose steep sides face the front. These ridges are deflected forwardly within the lateral border furrows and modified into chevron-like scales on the posterolateral corners and on the shoulder.

The pygidium is semicircular in outline and possesses a broad, flat to slightly concave border. The axis is well defined by axial furrows (except near the termination) and crossed by a single ring furrow. A second ring furrow is very faintly outlined on the lectotype. The four pleural furrows do not extend onto the broad border. The first interpleural furrow is initiated just behind the termination of the first pleural furrow and extends across the border to the lateral margin. The succeeding interpleural furrows are much less distinct, but are continuous across the border. They appear as direct continuations of the pleural furrows, but the presence of interpleural furrows on the pleural field, as well as on the border, of some specimens of *Bathyurus* (for example, *B. extans* illustrated by Whittington, 1953, pl. 65, fig. 4) suggests that separate names should be applied to these furrows. On the above specimen of *B. extans* and on undescribed species of *Bathyurus* from the Northwest Territories, the interpleural furrows are sigmoid in outline from the axial furrow to the margin and, often, their mid-points are tangential to the distal portions of the pleural furrows. If the adaxial portion of the interpleural furrows become effaced, the result will be a single curved furrow comprising the pleural furrow and the distal part of the interpleural furrow. This appears to be the case with the three posterior pleural and interpleural furrows on the pygidium of *B. superbus*.

Discussion

From *Bathyurus extans* (Hall) and its probable synonyms, *B. perplexus* Billings and *B. magnus* Wilson, *Bathyurus superbus* may be distinguished by its smooth, parallel-sided, and only slightly inflated glabella lacking prominent glabellar furrows, smaller palpebral lobes lacking palpebral furrows, broad and flat cephalic and pygidial borders, and shorter genal spines (Fig. 4E and J). The hypostome of *Bathyurus superbus* is very similar to those assigned to *B. extans* by Whittington (1953), but there remains some doubt about the correct assignment of the *Bathyurus* hypostomes collected at the Mechanicsville locality (that is, Whittington, 1953, pl. 65, figs. 13, 17 and this paper, Fig. 4G). Examination of large collections at the Royal Ontario Museum demonstrated that both

Fig. 4 A–D *Bathyurus superbus* Raymond. Upper Bromide Formation, Fittstown, Oklahoma.
A. Ventral view of hypostome, Ar 49046, × 6.
B–D. Oblique anterolateral, dorsal, and anterior views of cranidium, Ar 49047, × 2.
E–I *Bathyurus superbus* Raymond. Pamelia Formation, La Petite Chaudière, Mechanicsville, Ottawa, Ontario.
E. Dorsal view of incomplete exoskeleton, Lectotype, ROM 18788, × 1.
F. Dorsal view of incomplete thorax and pygidium, GSC 7422a, × 2.
G. Ventral view of hypostome, ROM 32374, × 2.
H,I. Dorsal view of cranidium, GSC 7422, × 2 and 4.
J,K *Bathyurus extans* (Hall). Lowville Formation, Great Bend, New York State. Dorsal view of exoskeleton, × 1.9 and detail of cephalon, × 5.7, USNM 306.


A
E
J
B
D
C
F
H
K
I
G

B. extans and *B. superbus* are present at this locality. The size of the hypostome illustrated in this paper suggests an assignment to *B. superbus* and it is quite possible that the other hypostomes at this locality belong to this species as well.

Bathyurus angelini Billings and *B. acutus* Raymond possess inflated glabellae with distinct lateral glabellar furrows, large palpebral lobes with deep palpebral furrows, and hypostomes with greatly inflated middle bodies. In addition, the pygidium of the latter species carries a stout terminal spine. *B. nevadensis* Ross has a wider glabella than *B. superbus* and a vaulted pygidium with steeply inclined borders. *B. angustus* Ross has a long terminal spine on the pygidium.

Order Phacopida Salter
Family Pterygometopidae Reed

Genus *Eomonorachus* Delo, 1935

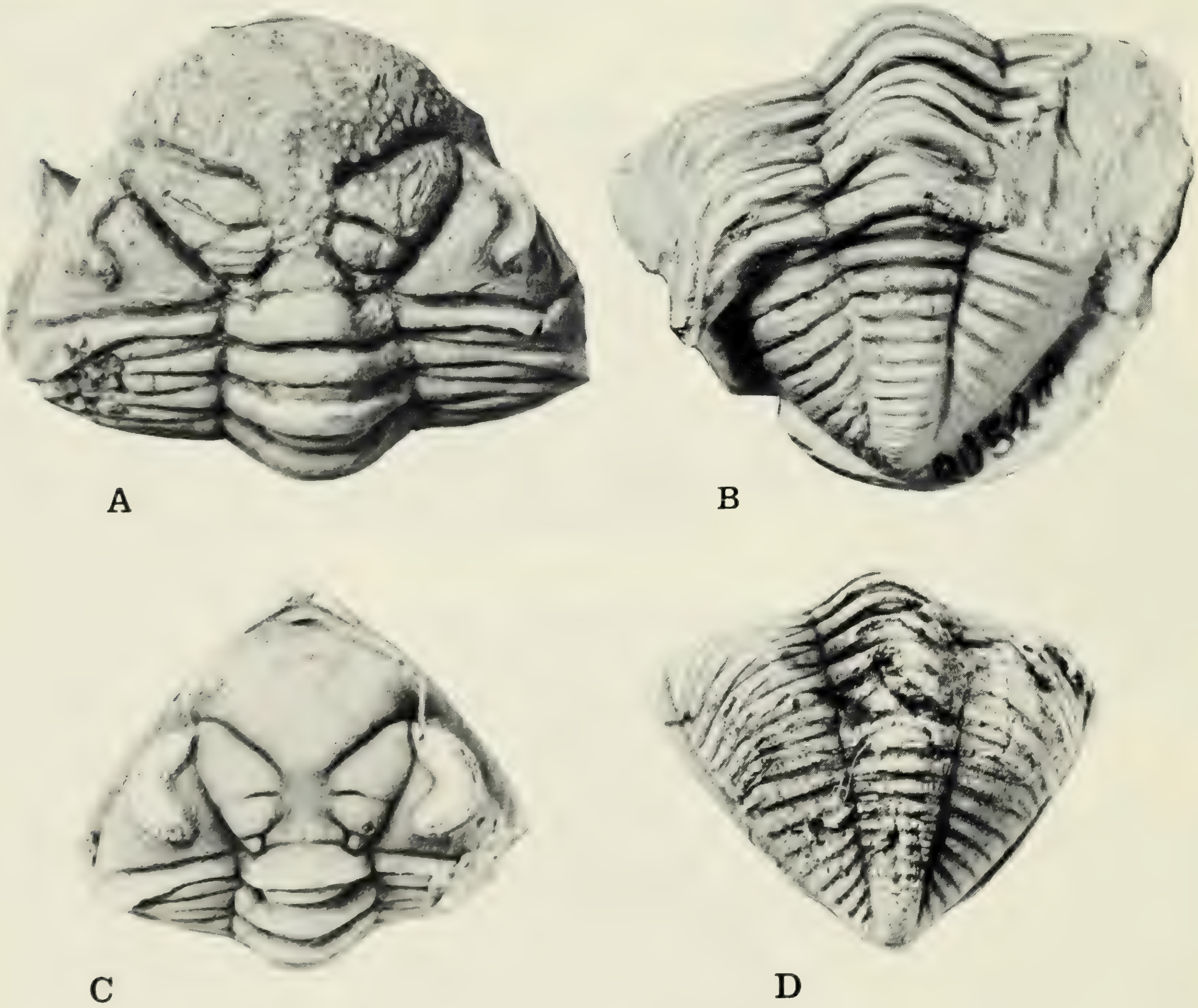


Fig. 5 A,B *Eomonorachus divaricatus* (Frederickson). Upper Bromide Formation, Fittstown, Oklahoma. Dorsal and ventral views of an enrolled specimen, Holotype, OU 5209, × 2.6.

C,D *Eomonorachus intermedius* (Walcott). Decorah Formation, Chatfield, Minnesota. Dorsal and ventral views of an enrolled specimen, USNM 41955, × 5.

Type species

Dalmanites intermedius Walcott from the Trenton Group of New York State.

Eomonorachus divaricatus (Frederickson, 1964)

Fig. 5A, B

1964 *Calliops divaricatus* Frederickson, p. 74, figs. 6–9.
1974 *Estoniops*? *divaricatus* (Frederickson), Shaw, p. 42, pl. 11, figs. 5, 6, 9, 12.

Holotype (and only known specimen)

An enrolled specimen lacking free cheeks (OU 5209) from the uppermost Bromide Formation (''Bromide dense''), 1 m below base of Viola Formation, Highway 99 Section, 5 km south of Fittstown, Oklahoma.

Discussion

Frederickson (1964) recorded the first trilobite find in the ''Bromide dense'' at Fittstown, a nearly complete enrolled specimen of a pterygometopid, which he designated the holotype of a new species, *Calliops divaricatus*. Shaw (1974) refigured the holotype and only specimen and assigned it, with query, to *Estoniops* Männil. The assignment is probably incorrect. The type species of *Estoniops*, *E. exilis* (Eichwald), has high and steeply sloping palpebral lobes, nearly transverse 3s glabellar furrows, and a furrow along the posterior branch of the facial suture. *C. divaricatus* has low and flat palpebral lobes, strongly forwardly diverging 3s furrows, and lacks furrows on the genal field inside the border furrow. *Calliops divaricatus* appears to be congeneric with such species as *Eomonorachus intermedius* (Walcott), *E. convexus* Ulrich and Delo, and *E. holstonensis* (Raymond) from late Middle Ordovician strata of North America.

From *Eomonorachus intermedius* (Fig. 5C, D), *E. divaricatus* differs in having a coarsely granulose glabella that expands more towards the front and which has a shorter (sag.) anterior lobe, less oblique 3s furrows, and relatively smaller palpebral lobes that are located somewhat farther out on the cheeks. The pygidia of the two species appear to be very similar and share a strongly annulate axis that extends to the posterior tip.

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I am grateful to Valdar Jaanusson, Naturhistoriska Riksmuseet, Stockholm for drawing my attention to the specimens of *Bathyurus superbus* from Oklahoma and for critically reading an earlier draft of this paper. Other specimens were examined through the courtesy of D.H. Collins, Royal Ontario Museum; T.E. Bolton, Geological Survey of Canada; F.J. Collier, National Museum of Natural History; and P.K. Sutherland, University of Oklahoma.

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